# Changing the Energy Equation with New, Smart and More Efficient Technologies

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Battelle

Pacific Northwest National Laboratory
Operated by Battelle for the U.S. Department of Energy

# Focus of Presentation

- Energy Generation
  - How we generate energy
  - How we use energy
  - The future of energy generation
- Energy Efficiency
  - Cost of efficiency
  - Impact of efficiency
  - Future of efficiency
  - Impact of Standards
- Lighting Efficiency
- Water—The Next Oil

# Every Scientific Presentation Must Contain an Energy Equation!

## Generation + Transmission + Distribution

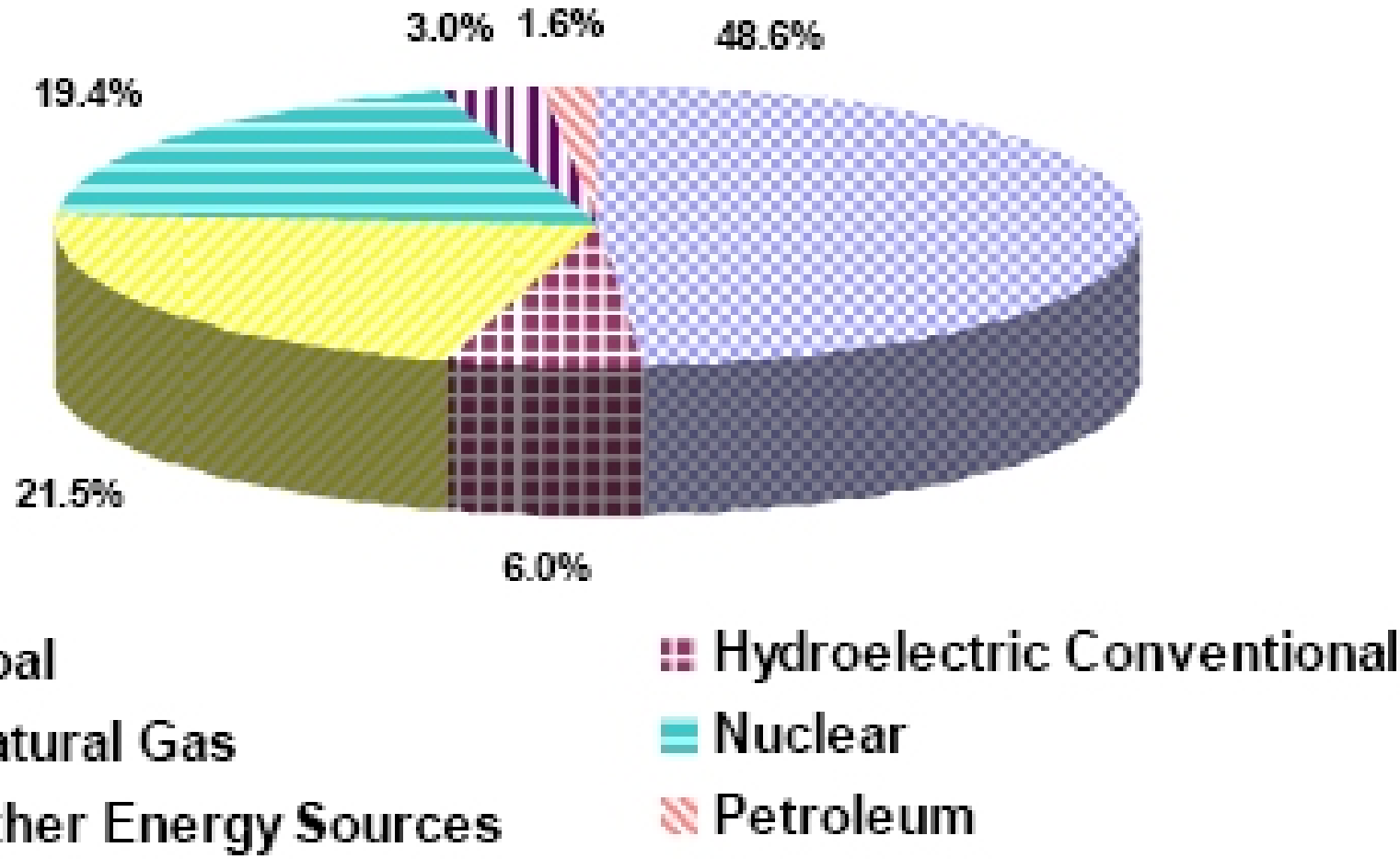
## End Uses

**Homes**

**Businesses**

**Industry**

# Today's National Electricity Generation Fuel Mix



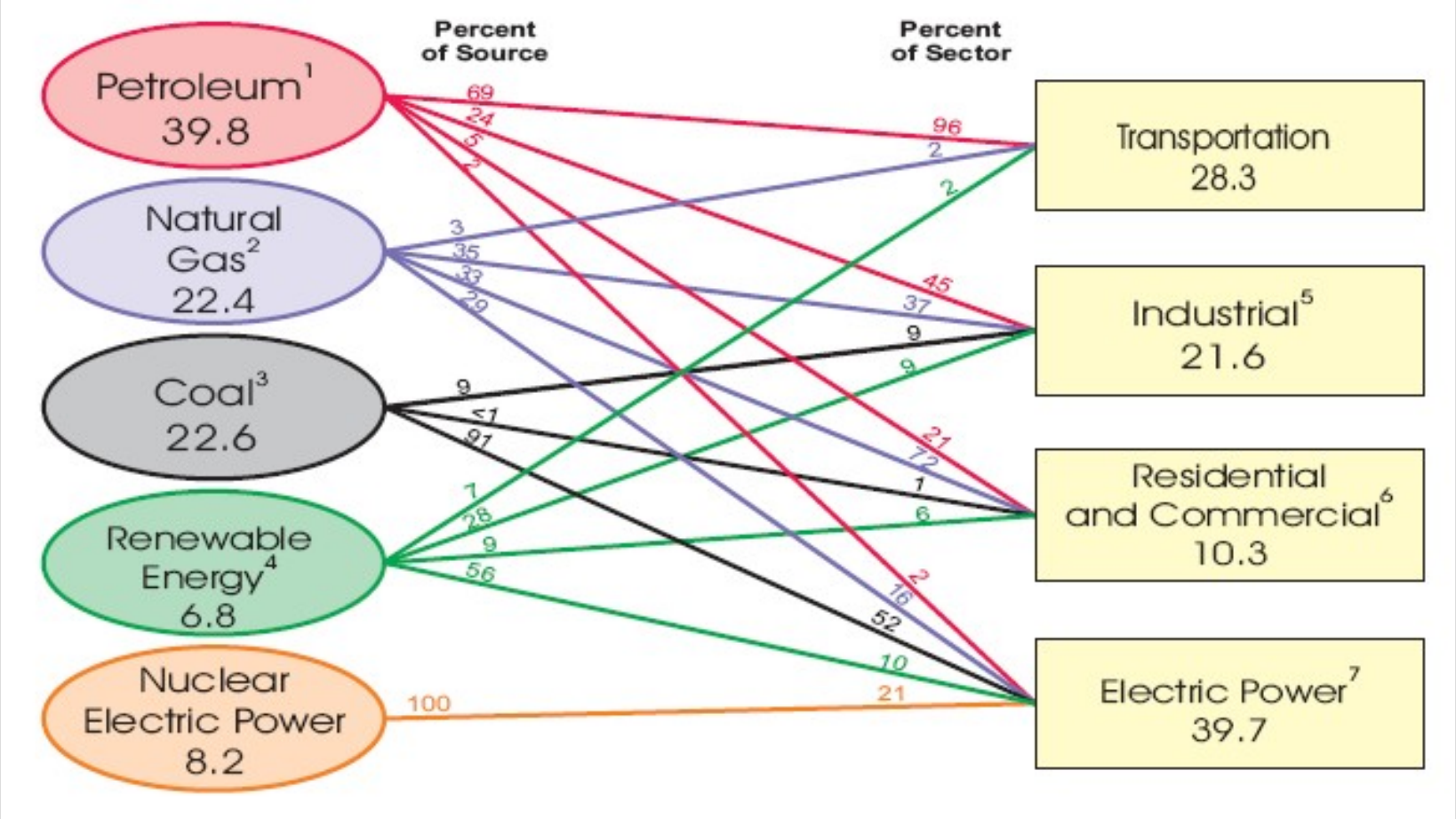

Source: www.eia.doe.gov

# Washington's Electricity Generation Mix

| Fuel Type | WA | U.S. |
|---|---|---|
| Coal | 26% | 49% |
| Natural Gas | 13% | 21.5% |
| Hydropower | 54% | 6% |
| Nuclear | 4% | 19% |
| Other (wind, geothermal, biomass) | 3% | 3% |

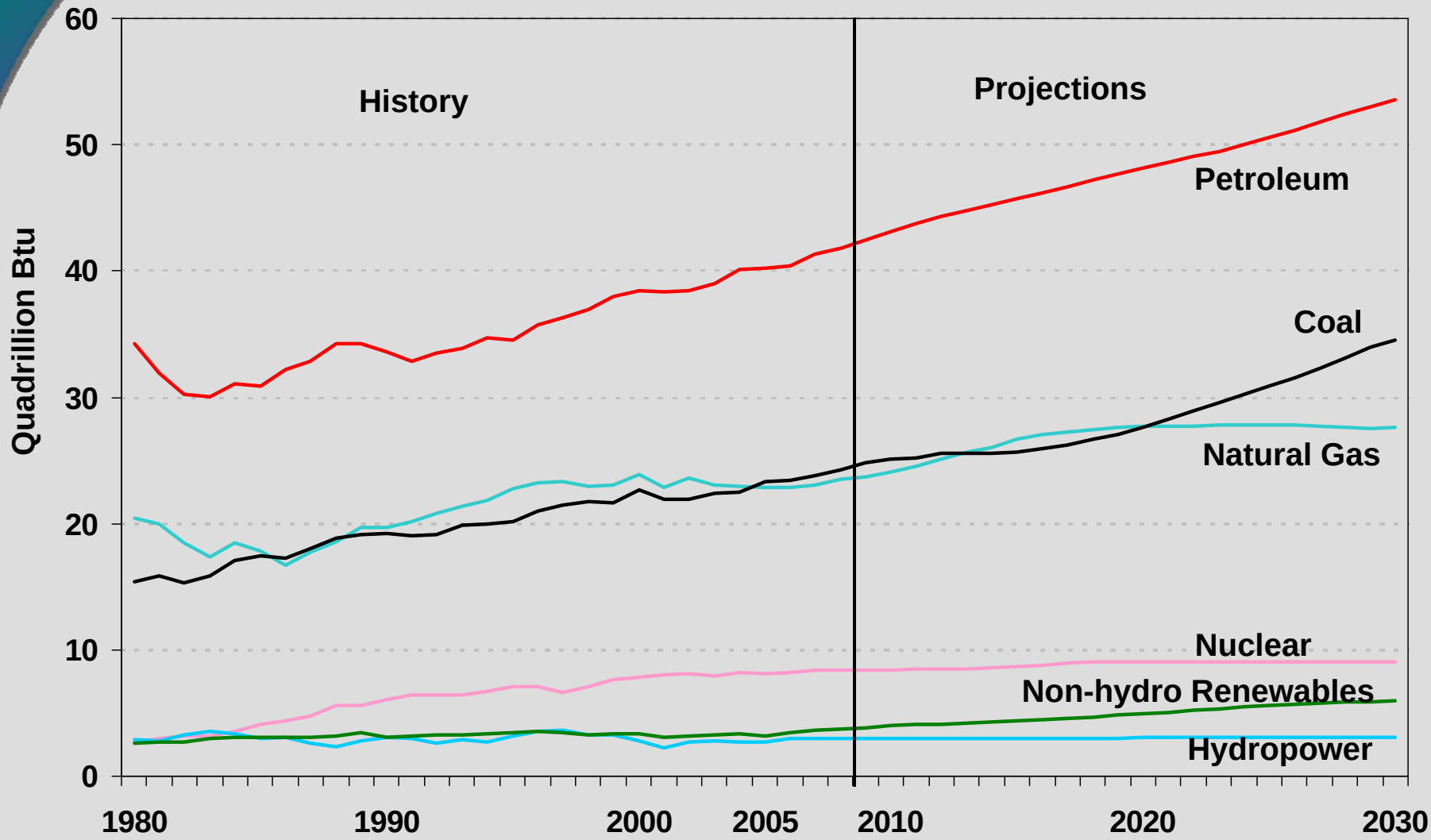
# National Energy Use by Sector

**Source** **End Use**



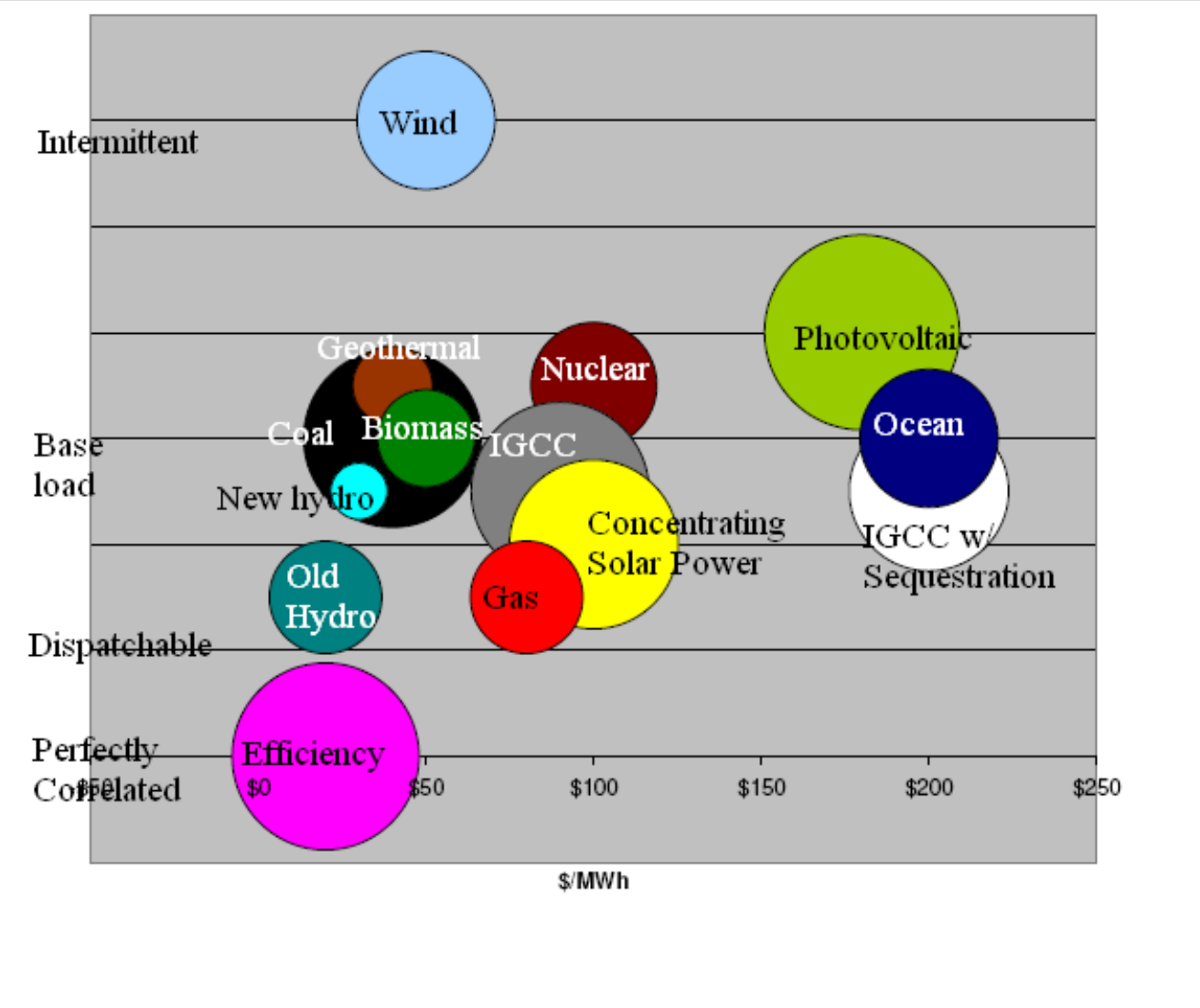

Source: www.EIA.doe.gov

# Energy Consumption by Fuel, 1980-2030

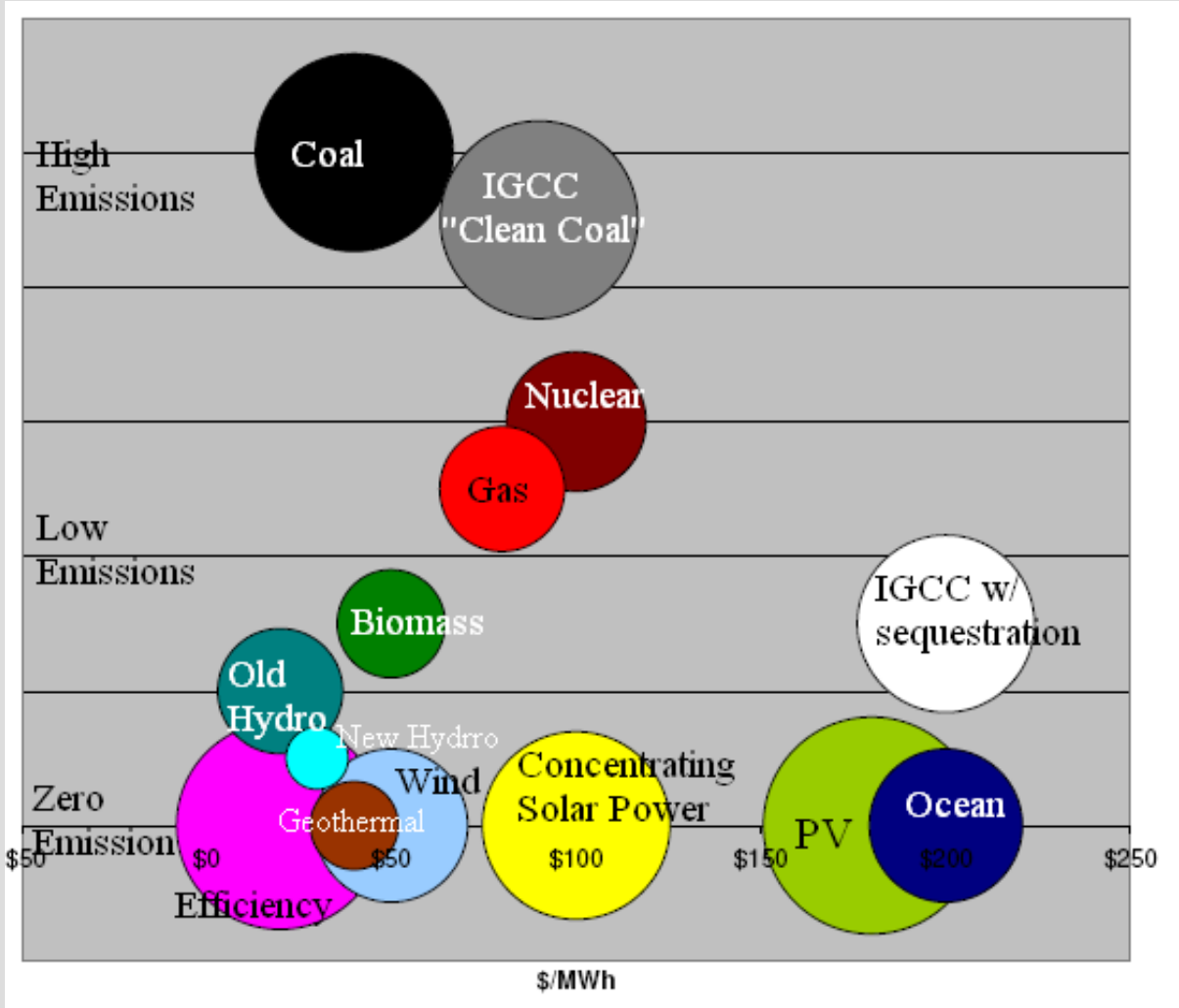



Source: www.EIA.doe.gov

# Electricity Supply Availability and Costs



# Electricity Supply Costs and Emissions



# Scoring Generation Options

| Utility-Scale Energy Generation Strategy | Major Issues for Deployment | | | | | |
|---|---|---|---|---|---|---|
| | Capital Cost ($/MWh) | Fuel Cost and Availability | Plant Location | Electricity Transmission | Environmental | Public Acceptance |
| Coal/'Clean' Coal | X | | X | X | X | X |
| Natural Gas | | X | X | | | |
| Nuclear | X | | X | | X | X |
| Hydro | | | X | X | X | |
| Ocean/Tidal | X | | X | X | | |
| Wind | | X | X | X | X | X |
| Geothermal | | | X | X | X | |
| Concentrating Solar | X | | X | | | |
| PV | X | | | | | |
| Biomass | | X | X | | | |

# Other Institutional Issues Complicate Renewable Industry Development

## Senators Ensign and Cantwell Introduce EE and RE Tax Credit Extensions

As reported in today's *E&E Daily*, Senators Maria Cantwell (D-WA.) and John Ensign (R-NV) plan to introduce legislation today to extend renewable energy tax incentives…. According to a summary of the measure lawmakers are drafting obtained by *E&E Daily*, the bill would provide *an eight year extension -- through the end of 2016 -- of the 30 percent business investment tax credit for solar energy and fuel cell projects. It also extends, for one year, availability of the production tax credit for wind power, geothermal, biomass and certain other types of power projects.* Under the plan, 10 years worth of production tax credits could be claimed for facilities placed in service through Dec. 31, 2009.

Source: ASERTTI News April 3, 2008

Update….April 10

The Senate voted 88-8 today to include roughly $6 billion worth of renewable energy and efficiency tax credits in a major housing bill the chamber passed shortly thereafter, but it remains unclear how or when a deal with the House may emerge.

# The Other Side of the Energy Equation

- One way to increase the national 'energy supply' is to decrease the 'end use' consumption. By doing so, less energy will need to be generated to serve the same customers and their equipment.
  - This has historically been deemed energy conservation demand-side management or efficiency. Others use the term "Nega-Watts."
- Efficiency cuts across all customer segments.
- Efficiency can be voluntary (e.g. turning off lights) or compulsory (e.g., federal equipment standards).
- Efficiency can be acquired in small increments and be tailored to a utility load profile and customer base.

# Scoring Energy Efficiency

| Energy Efficiency Strategy | Major Issues for Deployment | | | | | |
|---|---|---|---|---|---|---|
| | Capital Cost per kW or kWh | Fuel Cost and Availability | Plant Location | Electricity Transmission | Environmental | Public or Industry Acceptance |
| Voluntary Conservation | | | | | | X |
| Regulated Conservation | | | | | | X |
| Voluntary Demand Reduction | | | | | | X |
| Regulated Demand Reduction | | | | | | X |

# International Energy Agency (IEA)

"Using energy-efficient equipment is the most cost-effective short-term path to greater energy security and lower greenhouse gas emissions to combat climate change. It reduces pressure on energy resources".

**April 1, 2008. IEA Implementing Agreement for a Co-operating Programme on Efficient Electrical End-Use Equipment. www.iea-4e.org**

# ….Rediscovering Energy Efficiency

Puget Sound Energy finds creative ways to manage load growth
April 3, 2008

**New demand the size of Seattle to be added**

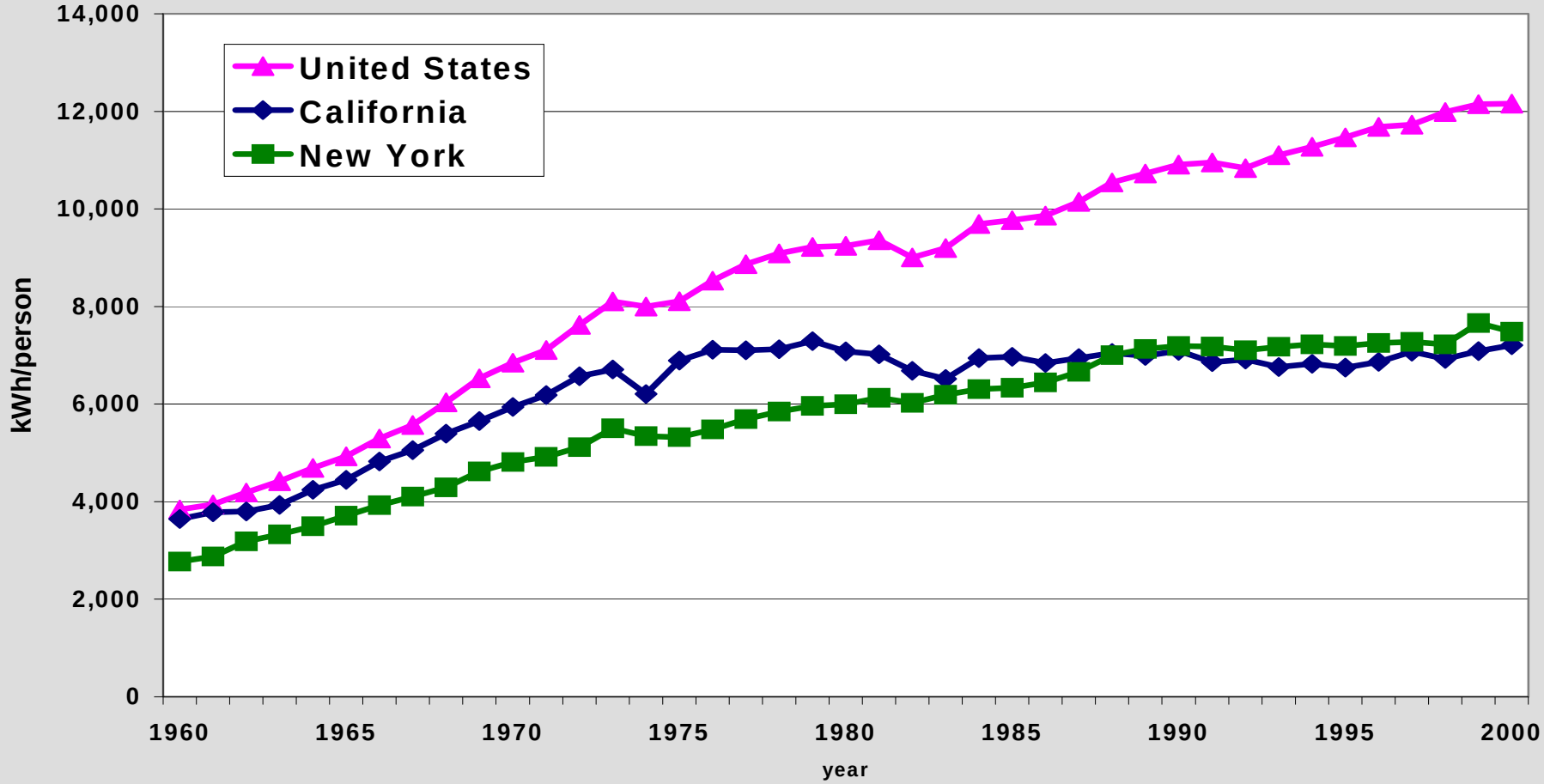
Puget Sound Energy is launching new energy efficiency offerings and added incentives to help customers conserve power and natural gas. To help pay for these programs, a new fee will be assessed on customer bills starting this month.

*Restructuring Today*, April 3, 2008

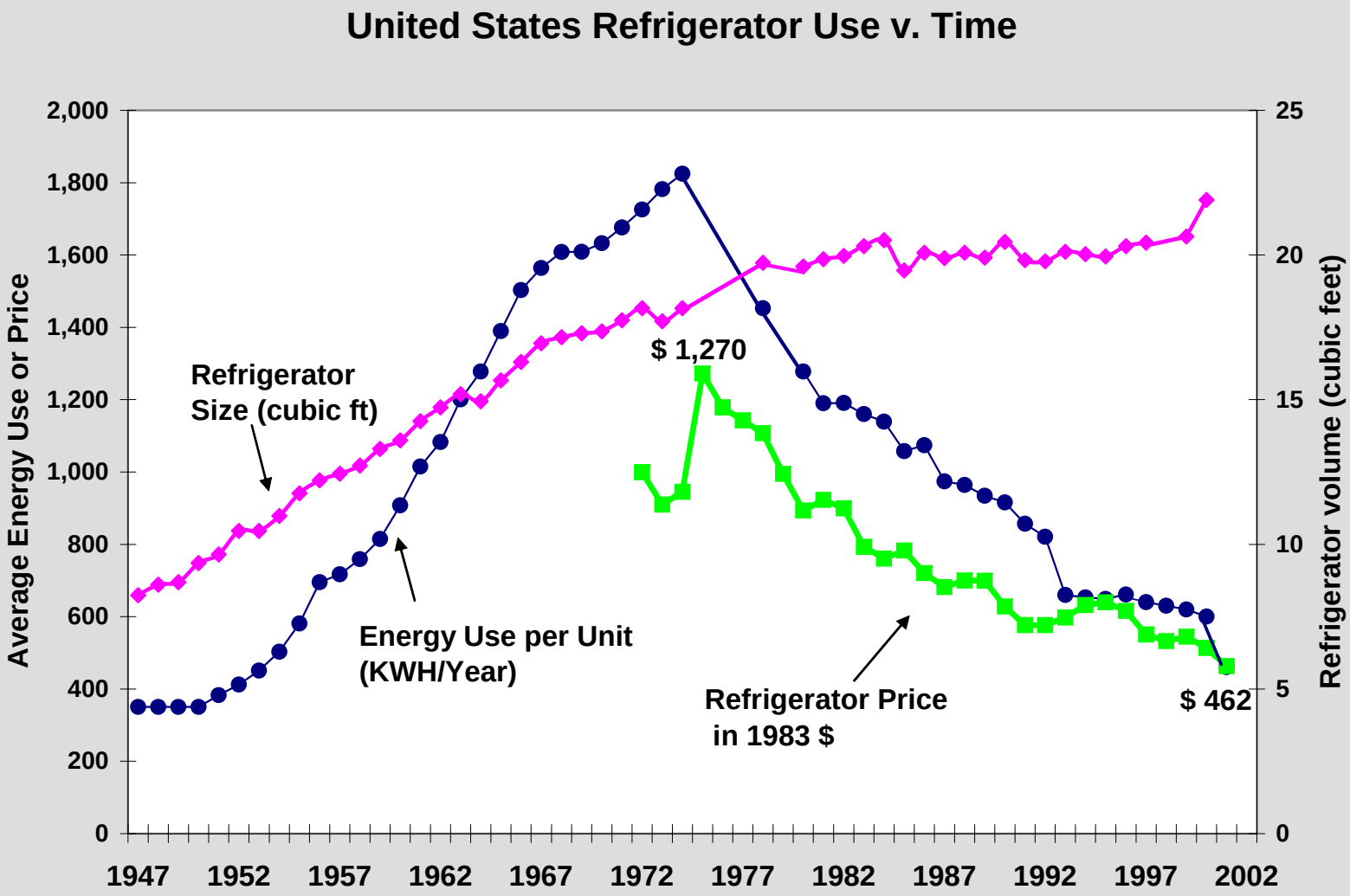
# Effects of Energy Efficiency on Consumption

**Per Capita Electricity Consumption**

Source: http://www.eia.doe.gov/emeu/states/sep_use/total/csv/use_csv

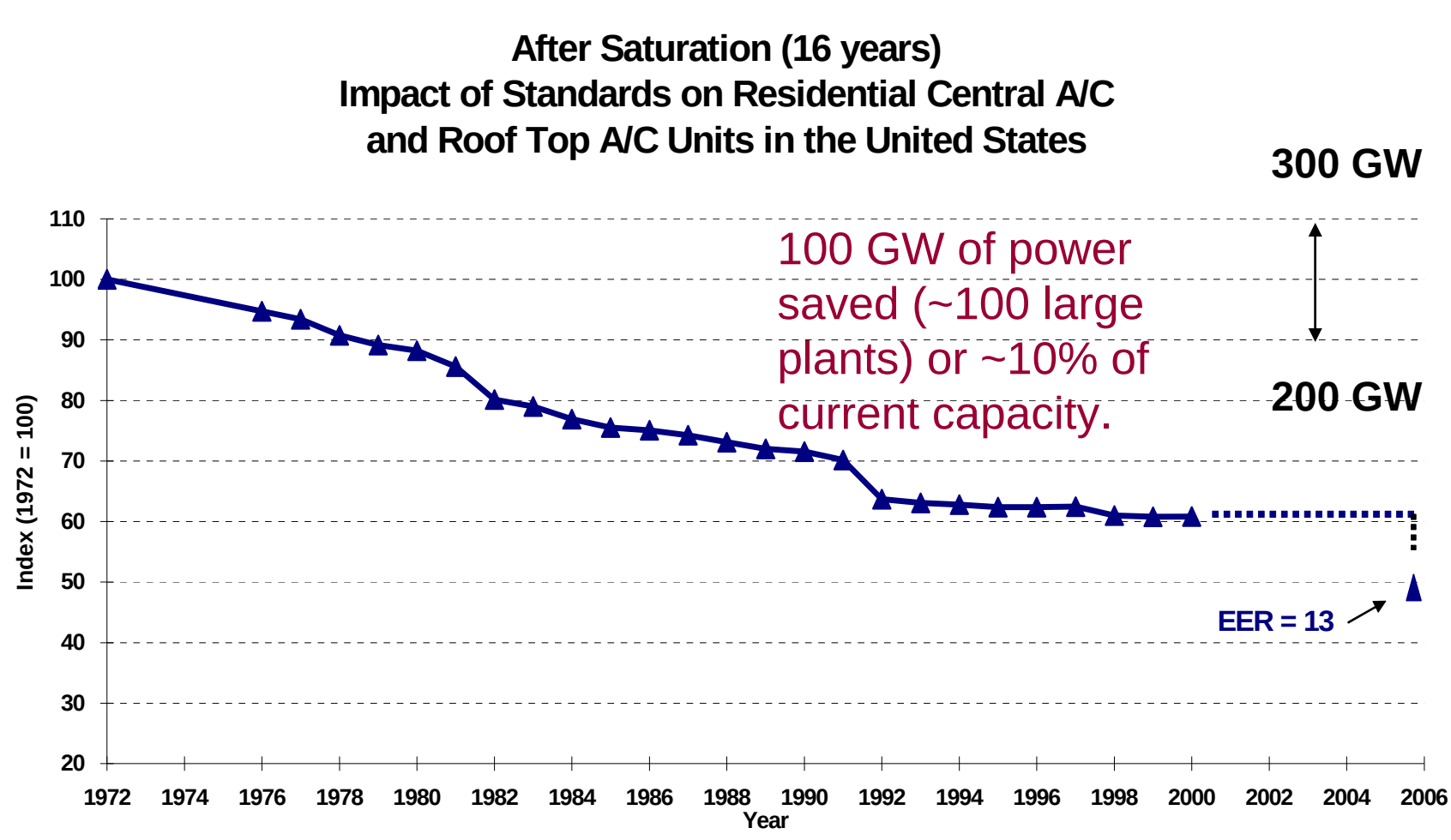


# Effects of Standards on Consumption




Source: David Goldstein, NRDC 2005

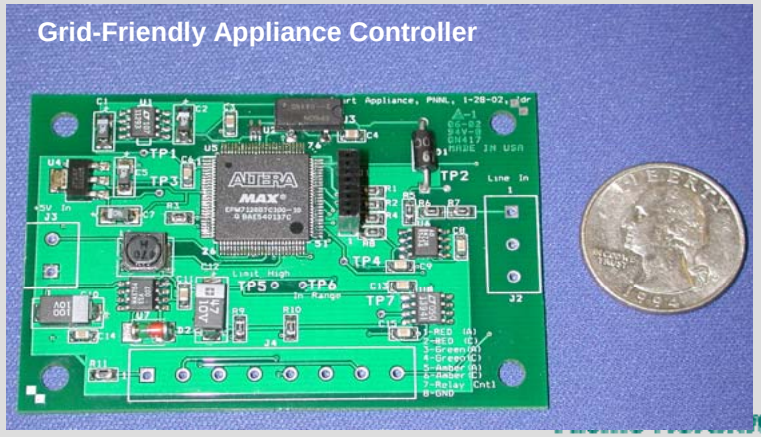
# Effects of Standards on Electric Load



# Grid Friendly™ Appliances

- Credit card-sized chip installed in appliances at factory
- Chip continually monitors power grid; when event-level fluctuations identified, appliance temporarily shut down for brief period (seconds to minutes) – with no inconvenience to consumer – until the grid stabilizes.
- Installed cost is ~$25/appliance
- Demonstration in Western Washington just completed.

www.gridwise.pnl.gov



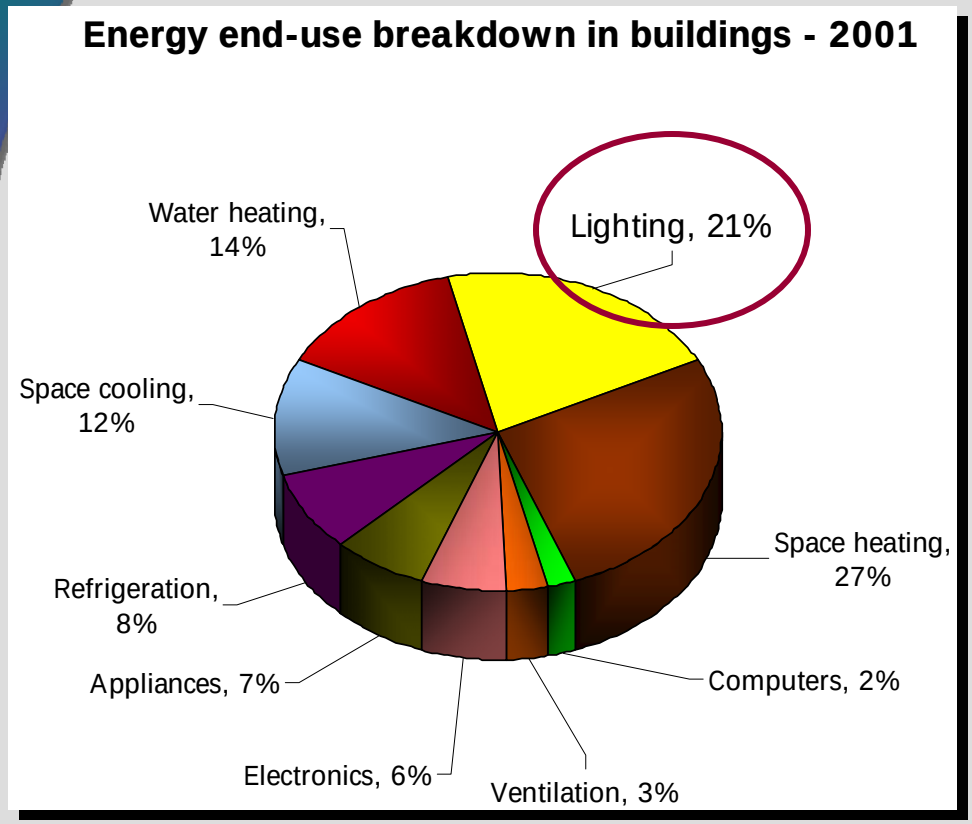
# Nationwide Energy Efficiency 2006

- 63 million MWh saved
  - Enough to power 5,000,000 homes for a year.
- 27,000 MW saved
  - Approximately 50 average-sized (500 MW) coal-fired power plants
- Energy efficiency programs costs were ~$1.2 billion
  - Average cost for energy efficiency: 2 cents/kWh
- Load management programs costs were $666 million

Source: www.eia.doe.gov

# Lighting Efficiency and the Future of Lighting

# Why Focus on Lighting?




U.S. DOE 2003 Program Core Databook

- Lighting is 21% of all energy used in buildings
- Lighting % continues to increase
- Lighting contributes significantly to electric demand
- Significant savings potential in efficiency lighting technologies

# Lighting Innovations & Facts

## Fluorescent Lamps

- T12 lamps (34-40W) were ubiquitous until early 1990s; T8 lamps were just penetrating the market.
- Compact Fluorescent Lamps (CFLs) entered the market in mid-70s, but were too long, too expensive and not satisfactory.
  - In mid-90s new CFL designs were introduced that were shorter, brighter and cheaper. Now a commodity' product @$1 to $3/lamp.
  - High-quality screw-in reflector lamps now emerging
- New 30W, 28W and 25W "Super" T8s are now entering market.
  - **Penetration: T12 = 35%; T8 = 60%; T5/T5 HO = 5%** (2006)
  - Most new T8 and T5 lamps are low mercury, high efficacy & long-life
  - Myriad of lamp/ballast combinations for almost any application.
- T5 lamps emerged in North America in 1996-98.
  - Enabled more compact and fewer fixtures with smaller profile.
  - Fastest growing linear lamp application.
- T1, T2, T6 lamps emerging with niche applications.

# CFL Screw-in Reflector (R) Lamp
## DOE Procurement

- The purpose of this project is to increase the availability and use of highly energy-efficient reflector compact fluorescent lamps (R-CFLs) for use in insulated ceiling rated airtight (ICAT) fixtures. Specifically, the procurement calls for R-CFLs that are:
  - Short enough to fit into recessed downlight fixtures
  - Deliver adequate light with a beam spread that is similar to equivalent wide flood-type incandescent R-lamps
  - Maintain light output levels and life span in high-temperature environment
  - ENERGY STAR compliant
  - Available at an affordable price

# CFL Screw-in Reflector (R) Lamp
## DOE Procurement

Current Reflector Lamp Products Available

- 4 manufacturers (GE/Feit/Philips/Sylvania)
- R30, BR30 and PAR38 sizes
- 15 – 26 Watts with 630 – 1300 lumens
- 6,000 – 10,000 rated life
- 1 dimmable product (GE 15 Watt)
- Available at several retail and internet stores.

**www.pnl.gov/rlamps**

Water – The Next Oil

# Lake Mead 2000

## Elevation 1214 Feet

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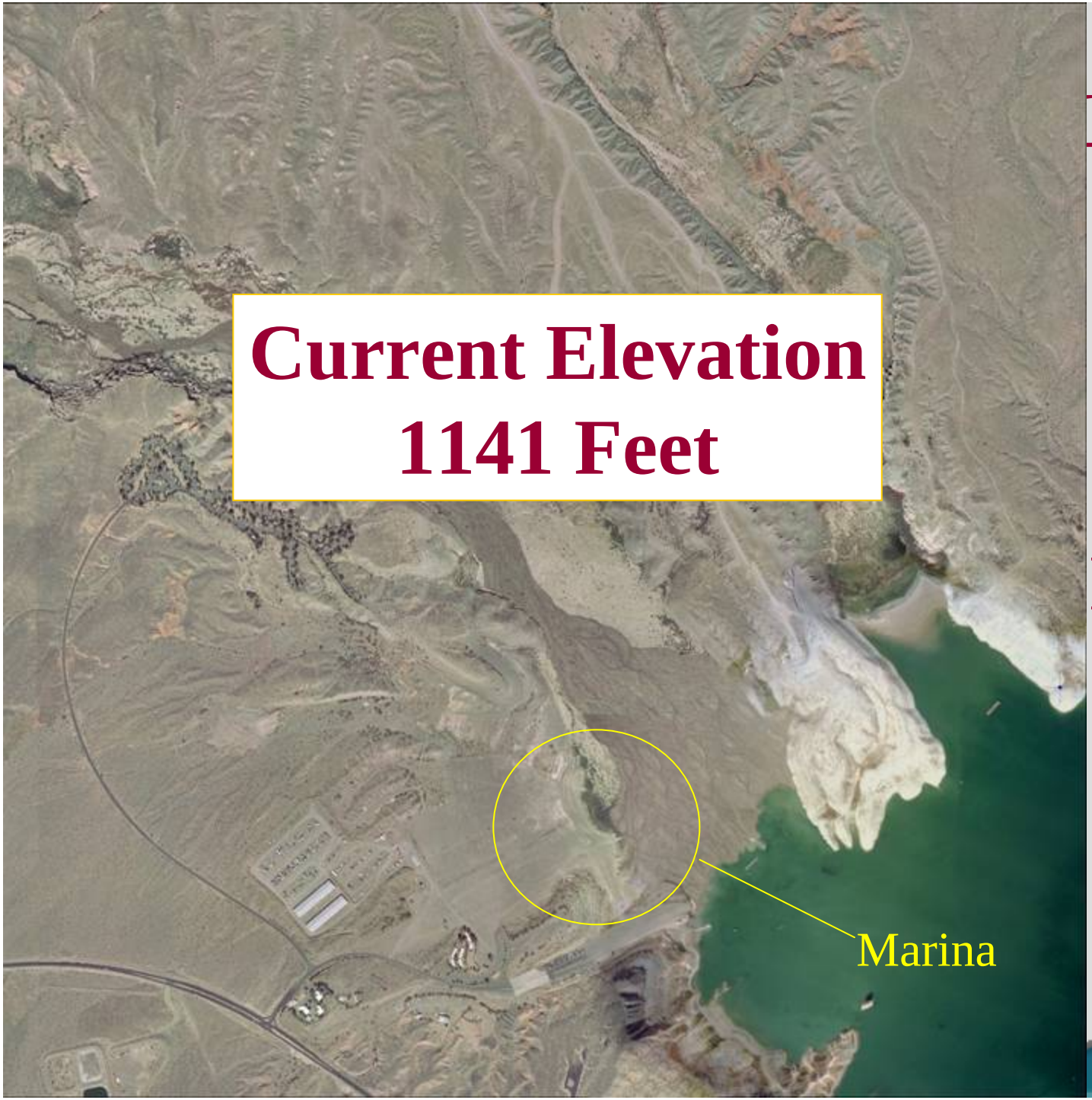


# Lake Mead 2006

## Elevation 1132 Feet

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# Water Efficiency

- Many energy-efficient products also save water and thus there is a dual benefit to society.
  - High performance clothes washers
  - Low-flow shower heads and faucet aerators
  - Efficient dishwashers
  - Commercial kitchen appliances
- Many water utilities are implementing programs that are similar to electric utilities due primarily to increasing demands and drought conditions
- Federal standards now regulate many plumbing products.